CLAIMS

What is claimed is:

1. A method of determining electromagnetic properties of an inhomogeneous target, comprising:

a) repeatedly irradiating the target to be imaged with short pulses of electromagnetic energy to induce thermoelastic waves within the target;

b) detecting mechanical displacements associated with said thermoelastic waves using a magnetic resonance (MR) scanner; and

c) steps of using the displacements of the thermoelastic waves with a mathematical model to compute the electromagnetic property distribution in said target.

2. The method of claim 1, further characterized in that the frequency of the electromagnetic energy is within the range of 300 MHz to 3 GHz.

3. The method of claim 1, with further improvement characterized by combining an MR-compatible antenna array to determine electrical properties of the inhomogeneous target in the MR environment, and steps of transmitting a microwave signal through an active transmitting antenna, receiving said microwave signal through an active receiving antenna, and using said measured electric field values with a mathematical model to compute an electric property distribution in said target.

4. A method of determining electrical properties of an inhomogeneous target in an MR environment, including steps of measuring electric field values external to said target using an antenna array that is MR-compatible, in which an active transmitting antenna transmits a microwave signal, and an active receiving antenna receives said microwave signal, and steps of using said measured electric field values with a mathematical model to compute an electric property distribution in said target, the improvement to compensate for the effect of a non-active antenna of the array on said measured electric field values comprising steps of:

presenting a matched characteristic impedance to a non-active antenna of an antenna array; and

modeling said non-active antenna as an electromagnetic sink in a numerical model.

5. The method of claim 4, further characterized in that the frequency of the electromagnetic energy is within the range of 300 MHz to 3 GHz.

6. A system for determining electromagnetic properties of an inhomogeneous target, comprising:

(a) a source for repetitively irradiating the inhomogeneous target with short pulses of electromagnetic energy to induce thermoelastic waves within the target; and

(b) a magnetic resonance scanner for detecting the thermoelastic waves.

7. The system of claim 6, further characterized in that the frequency of the electromagnetic energy is within the range of 300 MHz to 3 GHz.

8. A method for encoding motion within biological tissue comprising:

generating an imaging gradient to encode the harmonic or wave motion within said tissue by simultaneously encoding position and motion.

9. A system for encoding motion in a sample or subject by use of MR elastography characterized by means for producing and resolving a directional imaging gradient or combinations of directional imaging gradients to encode position within the sample or subject.

10. The system of claim 9, wherein the means for producing and resolving a directional imaging gradient decreases image capture and reconstruction time relative to use of a nondirectional imaging gradient.

11. The system of claim 9, wherein the means for producing and resolving a directional imaging gradient increases signal to noise ratio compared to use of a nondirectional imaging gradient.

12. The system of claim 9, wherein the means for producing and resolving a directional imaging gradient cycles the direction of the phase accumulated from responsive motion of a specimen.

13. The system of claim 9, wherein the means for producing and resolving a directional imaging gradient cycles the direction of the phase accumulated from responsive motion of a specimen by switching the sign of said single gradient and subtracting total phases of the sensed motion.

14. Methods and systems of claim 9 that determine responsive motion of a specimen in each of multiple directions.